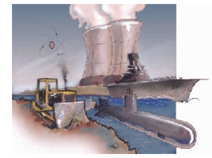
Office of Science & Technology

Specialized Separation Utilizing 3M Membrane Technology



Developer: 3M Corporation
Contract Number: DE-AR21-96MC33089
Crosscutting Area: ESP

Mixed Waste FOCUS AREA

Problem:

At Department of Energy (DOE) sites where radioactive materials were processed for weapons development and production there is waste which needs to be remediated. Much of the waste occurs in the form of aqueous solutions. Water in spent nuclear fuel storage basins and contaminated groundwater are two examples. Separating radionuclides and other contaminants from these solutions is necessary before they can be discharged to the environment. Often, contaminants must be reduced to levels below EPA drinking water standards, and radionuclides and contaminants that have been separated from the solutions must be put in a form that can be either stored or processed further.

Solution:

Ion exchange and adsorption, two well-established techniques for remediation of aqueous waste streams are often used for this purpose. Typically, ion exchange and adsorbent particles suitable for use in columns have diameters greater than about 200 micrometers because smaller particles are difficult to support and offer very high flow resistance.

Particle-loaded membranes have been developed that contain ten to

thirty micron-sized particles. There is great flexibility in particle selection and it is possible to fabricate membranes from just about any particle provided it is properly sized. These membranes have been fabricated into cartridges which can be installed in the same vessels used for filters. In practice they function just like columns albeit ones with very large diameter compared to height. The photo shows a nominal ten-inch cartridge though much larger ones can be manufactured.

Benefits:

- A superior level of decontamination can be achieved

- Volume of secondary wastes including material that must be stored is reduced

- Flow rate at which waste streams can be processed is much higher for cartridge-based systems because the kinetics of exchange is much more rapid due to the small particle size

- Captured radionuclides are immobilized on cartridges which can be easily handled and packaged for storage or further processing

- The footprint of a cartridge-based system is small compared to columns making it easier to protect workers from radiation

- Through selection of the proper particle, wastes can be captured selectively, thus avoiding generation of mixed wastes that are hard to dispose

- Development of a water sampling system through adaptation of Empore™ technology will provide rapid analysis for strontium (Sr), cesium (Cs) and radium (Ra)

Technology:

The project consists of two primary endeavors: 1) development of a spiral wound cartridge system for remediation applications (Empore™) which is cost effective in large-scale applications, and 2) adaptation of the existing Empore™ for development of a rapid on-site water sampling technology.

Technology development has been evolutionary starting with the

Empore™ membrane that was made from tiny fibrils of polytetrafluoroethylene (PTFE) and small particles. Because PTFE is embrittled by radiation, a different fibrous matrix was introduced which resists radiation. Since the process for fabricating each of these membranes is quite different, considerable effort was expended in developing WWL™, the term used for the radiation-resistant web. Converting WWL™ into cartridges involved additional development that is still ongoing. Systems for carrying out separations have also been developed along with a pilot-scale device. The pilot-scale system includes filters for removing particulates that would otherwise clog absorber cartridges, vessels that house the absorbers, and controls mounted on a portable drip tray/support.

A number of demonstrations of this technology have been conducted starting at Idaho National Engineering and Environmental Laboratory (INEEL) where Cesium-137 (^{137}Cs) and Strontium-90 (^{90}Sr) were removed from acidic tank waste. About a liter of solution was processed at laboratory scale in one of their hot cells. Larger scale demonstrations have been conducted at West Valley Nuclear Services (WVNS), INEEL and Hanford. At WVNS, Technetium-99 (^{99}Tc) and ^{137}Cs were captured from more than 4000 gallons of water. At INEEL ^{137}Cs and ^{90}Sr were removed from more than 800 gallons of water. The pilot-scale unit mentioned above was used at Hanford for removal of ^{137}Cs and ^{90}Sr from the contaminated groundwater at N Springs and from the N Basin fuel storage pool. Potassium cobalt hexacyanoferrate (KCOHEX) was the adsorbent used for ^{137}Cs and sodium titanate was used for ^{90}Sr. In the most recent demonstration at Paducah, KY, ^{99}Tc was removed from 22,000 gallons of contaminated water using one of the new cartridges.

Demonstrations are scheduled at Savannah River Site (SRS), INEEL and Argonne National Laboratory. At SRS, polychlorinated biphenyls (PCBs) will be removed using activated carbon-containing cartridges and ^{137}Cs will be removed using KCOHEX. The design flow rate will be 5-10 gallons/minute with a 24 hour per day operation planned so that more than 8000 gallons/day will be processed.

3M and Argonne National Laboratory are jointly developing a rapid water sampling and analysis system based on Empore™ membrane solid-phase extraction (SPE) technology. Rapid water sampling methods and equipment based on Empore™ SPE membranes have been developed in Phase I for representative radionuclides (^{99}Tc) and heavy metals (Pb).

Contacts:

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